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Critical Care Delivery: The Experience Of A Civilian Terrorist Attack

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ABSTRACT

It has been recognised for some time that a terrorist incident was threatened in the UK and it has been noted previously in the JRAMC that the locations for terrorist atrocities are likely to be more diverse than previously experienced(1). July 7th 2005 witnessed the first terrorist suicide bombing on the UK mainland, targeting the public transport system in London. These attacks were unprecedented in both scale and intensity but they were anticipated in London. However there were clear difficulties, relating to multiple sites, their location underground and early problems with communication (2). This article highlights some of the experiences and learning points of the Intensive Care Medicine Service at the Royal London Hospital (RLH) in the wake of the July 7th bombings. The RLH was the single biggest receiver of casualties (195); seven of whom were admitted to the Intensive Care Unit.

The Defence Medical Services have tri-service representation (both regular and reserve) at the RLH in Emergency Medicine and Pre-hospital Care, Surgical Services and Intensive Care Medicine.

Background

Intensive Care beds within Barts and the London NHS Trust are split over three sites. There are sixteen staffed general ICU beds at the Royal London Hospital (RLH), eight ICU beds at the London Chest Hospital (LCH) and eleven at St Bartholomews Hospital (SBH). All elective cardio-thoracic surgical cases take place at LCH and SBH; there are no accident and emergency departments at these sites.

The Intensive Care Unit (ICU) at the RLH has predominantly an emergency workload and all the beds provide level 3 care. (Ventilation capable) High dependency beds (level 2 care) are provided in a six bedded surgical HDU, staffed and managed separately by surgical teams.

In 2004 there were 703 admissions to the ICU, only 14 of these were elective admissions. 241 cases were emergency medical admissions; approximately 30% of the workload was trauma related, due to the co-location of the Helicopter Emergency Medical Service (HEMS). There was an average length of stay of six days and a unit mortality of 21%. (Standardised Mortality Ratio of 0.87). As there are very few elective admissions to the ICU at the RLH site it means that there is no buffer that can be created by cancelling planned work in the event of a multiple casualty incident. On July 7th the ICU received seven critically injured casualties.

Preparation

ICU bed availability is a limited resource in most hospitals and there is growing acknowledgement that critical care delivery will occur away from the ICU setting (3). It was the expectation that full level 3 care would need to be delivered outside the RLH ICU once it became clear how many casualties there were. Preparations were made on this basis.

Although the first patient was admitted to ICU at RLH at approximately 14.00, the critical care response commenced with the declaration of the major incident at approximately 09.20. On the morning of 7th July there were fourteen patients in the intensive care unit. Nine were ventilated; three ventilated patients were identified as being fit for transfer. At the time the major incident was declared one patient was expected into the ICU from the wards. LCH and SBH cancelled further elective cardiothoracic cases and offered intensive care beds, accommodating those patients identified as able to move. Fortunately there was a regional anaesthetic registrars teaching session taking place at the RLH on the 7th July and these doctors were identified as potential escorts for level three patients requiring transfer. Surrey Ambulance Service was utilised to perform patient transfers, thereby leaving London Ambulances to be involved in the pre-hospital response.

Four non-ventilated patients were transferred to other hospital beds. All HDU beds except one were cleared and patients moved to ward care. The five empty HDU beds were set up as satellite ICU beds with a further four satellite beds set up in the operating theatre recovery. This work was done mainly by the critical care outreach team. During this preparation phase there were three cardiac arrest calls unrelated to the major incident; all required attendance by the cardiac arrest team and ICU registrar.

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Intensive Care Medical response

There were five ICU consultants in the RLH at the time the major incident was declared; two more subsequently were able to attend. (Of this total six were anaesthetists and one physician) None of the senior medical staff were notified via the paging system or mobile phone network that a major incident was declared. Runners proved more effective in disseminating this information.

As patients were triaged to theatre, there was ICU consultant and registrar input in the resuscitation room and also in the operating theatre complex. Although this split staff geographically it did mean there was regular communication and early management regarding the progress of patients who may ultimately be admitted to ICU.

Command and control

The senior nurses office was set up as the ICU co-ordination centre, with the ICU matron taking a lead administrative roll in organisation and dispatching runners to get updates, particularly from the operating theatre. A local supermarket provided free food for the ICU staff during the afternoon of July 7th. As the day progressed one ICU registrar was assigned as a computer-based clerk; producing an updateable worksheet on each individual patient with details of injury pattern, investigations, results, completed and planned surgery. This was the singularly most useful effort and made the planning and organisation of subsequent care for each patient much easier. Patients had been given casualty numbers at the scene, which stayed with them in hospital.

Patient admissions

Seven patients were admitted to the intensive care unit, all were post-operative and sedated and ventilated. Triage had taken place in the resuscitation room by a senior surgeon. Due to the rapid triage to theatre from the emergency department system no patients subsequently admitted to ICU had fully completed secondary surveys and several had missing radiology.

Immediate clinical issues

There is a clear trauma radiology policy at the RLH, which involves the reporting of trauma films by a senior radiologist to allow radiological spinal clearance to facilitate removal of cervical collars in those patients who are unlikely to be clinically spinally cleared within 24hrs. Due to the rapid triage this did not occur and no patients had spinal clearance on arrival in ICU; this put a huge extra burden on nursing staff, as all these patients needed to be log-rolled for extended periods. Several returned to the emergency department on the following day to have completion of their trauma radiology.

It was unclear whether patients had received tetanus toxoid vaccine. It was unknown in the early stages that there had been suicide bombers and the question of tissue implantation became of importance later. All ICU patients had a hepatitis and HIV screen after discussion with a consultant virologist. All patients received tetanus toxoid and hepatitis B vaccine in ICU; post exposure prophylaxis for HIV was not commenced on any patient empirically. Broad spectrum antibiotics to cover aerobes and anaerobes were commenced in each patient, as all had contaminated wounds, in accordance with microbiology advice.

The casualty numbers given at the scene

Table 1. Patient profile of Intensive Care Admissions.

Age	Primary condition	Secondary condition	ICU Length of stay	ISS	SAPS II	SAPS II Probability of survival	Outcome
32	Blast injury (Bilateral lower limb amps)	Hypovolaemia	12	22	24	94.18	Survived
49	Blast injury (Bilateral lower limb amps)	Fractured ribs	6	27	39	77.04	Survived
36	Hypovolaemia	Compartment syndrome	17	22	46	63.04	Survived
48	Blast injury (Amputation of upper limb)	Compartment syndrome	22	11	45	65.23	Survived
53	Blast injury (Bilateral lower limb contusions)	Compartment syndrome	14	17	29	91.33	Survived
44	Extradural haematoma	Facial trauma	7	20	29	91.33	Survived
30	Hypovolaemic shock	Traumatic haemothorax	9	34	70	16.16	Died
41.7			**12.4**	**21.86**	**40.29**	**70.09**	

SAPS = Simplified Acute Physiology Score
ISS = Injury Severity Score

proved problematic; these numbers were not transferable onto the hospital system and this made obtaining laboratory results and cross-matching unnecessarily complicated.

Prolonged care phase

The average length of intensive care stay was twelve days; one patient stayed for twenty two days and unfortunately one patient died. Multiple extra theatre sessions required scheduling to accommodate the need for repeat plastic surgical and orthopaedic procedures. This phase of care has received less attention previously in the medical literature than it deserves. Early skin grafting for large raw areas was discussed with the plastic surgeons and for several patients joint planning between different surgical teams was required. The patient profile is detailed in Table 1; the injury patterns were consistent with primary and secondary blast injury. An Injury Severity Score (ISS) >15 is regarded as the cut-off for severe injury and six patients fulfilled this criteria. The patients were also scored using the Simplified Acute Physiology Score (SAPS II) with probability of survival calculated. There was an overall likelihood of survival of 70%; this figure was weighted by one patient with a low predicted survival, who subsequently died.

Discussion

The problems faced by the events of July 7th 2005 were not unique and are more frequent in other parts of the world where they are associated with insurgency warfare, notably Israel and Iraq (3). However, in the context of UK civilian practice this was a unique event. There were 52 dead and 700 injured (Madrid 2004 – 191 dead and 2062 injured) Even at a hospital with the national trauma profile of the RLH there was much to be learnt. A lot of our learning has taken place in the weeks and months since these events by open discussion with medical, nursing and management colleagues.

1. Clinical Spectrum

a) Ventilation

Much has been written in the literature about injury patterns and treatment following blast injury. There was a perceived risk of acute lung injury (ALI) due to blast lung protective ventilation strategies were utilised. (Using low tidal volume ventilation where appropriate). Blast lung as a discreet entity is reported as occurring in 50% of casualties of blast injury in enclosed spaces (4). This was not our experience and early acute lung injury was not a feature in any of our patients.

b) Haemodynamics

The patients requiring amputation had massive fluid requirements probably from evaporative and third space losses. A central venous saturation was used (ScvO2 > 70%) as an early indicator of global perfusion adequacy and invasive haemodynamic monitoring was instituted early. (Cardiac output monitoring).

One patient had marked haemodynamic instability on ICU, an urgent repeat FAST (Focused Abdominal Scan for Trauma) scan and trans-thoracic cardiac echo were performed, eventually proceeding to surgical review and laparotomy.

c) Radiology

Hard copies of X-ray films and CT scans were often removed by surgical teams and ideally they should have been housed in a single area, accessible 24hrs a day but not removable.

We have now requested that all X-ray reporting be recorded digitally, onto a centrally accessible storage media, to aid information retrieval out-of-hours. A recently installed digital link for CT scanning should reduce some of these problems in the future.

Orbit and facial views were not routinely requested at initial head CT scan for those requiring it; this should have been done as blast injuries to the face are associated with a high incidence of bony orbital and soft tissue injuries.

d) Other considerations

Repeated limb compartment checks and continued presence of distal pulses was recorded in all, delayed fasciotomies were required in some cases; diagnosed by a combination of clinical vigilance and rising serum creatinine kinase levels.

Ophthalmology review of every patient to look for 'X-ray invisible' foreign bodies was also performed with a portable slit-lamp. Up to 28% of blast survivors have eye injuries (5).

Otoscopy was performed by ENT surgeons on all the ICU patients; all had at least one perforated tympanic membrane; indicating close proximity to the blasts. Although rupture of the tympanic membranes serves as a convenient sensitive marker for exposure to blast it does not predict the progression to pulmonary complications. This was the case in our ICU patient group. Notably there were no ICU referrals over subsequent days for patients who had been seen elsewhere in the hospital with tympanic perforations, who then went on to develop pulmonary pathology. In the Madrid train bombings; of seventeen critically ill patients with pulmonary complications, thirteen had ruptured tympanic membranes and four did not (5).

2. Organisational Spectrum

Relatively little has been published about the command and control aspects and man-

agement of the threat of such incidents. Even with a comprehensive major incident plan and a daily experience of polytrauma management there were still some obvious deficits. In the first hour after the bombings; the hospital switchboard received 25,000 excess calls which rendered the internal phone system non-functional for the rest of the day.

Initial access to the resuscitation room appeared chaotic; if there had been any CBRN casualties or secondary devices then it probably would have resulted in exposure of many front-line hospital staff to unnecessary danger. In the sarin gas attack on the Tokyo underground in 1995; 38% of critical care patients were in an ICU before the nerve agent responsible was identified and ICU clinical staff were affected by secondary exposure to sarin (6). It is not (and never will be) satisfactory to suggest that the decontamination of casualties from such incidents will occur in the pre-hospital phase. Bedside toxicology and chemical agent monitors should be available in the ICU setting to screen for possibility of exposure. This did not occur on July 7th and a review of all patients and their patho-physiology occurred on July 8th in conjunction with senior clinicians from the Health Protection Agency. Intensive care services have an important position in relation to these type of casualties and subsequent major incident plan reviews have reflected this scenario (7).

Patients had been given casualty numbers at the scene, which stayed with them into hospital; this proved problematic for several reasons. The numbers gave no indication of the site of the incident, which had ramifications when identification became necessary. These casualty numbers were incompatible with the hospital administrative system.

Patients were still being admitted from theatre after midnight. The duty consultant with the incoming night junior staff conducted a specific ward round of the 'non-bombing' ICU patients, who still constituted the majority of ICU patients.One patient with sepsis was identified during this ward round and a significant upgrading in his care was initiated. A review of all patients occurred at 1am and the last ward round finished at 3am, three intensive care consultants remained resident overnight, as well as one additional senior ICU registrar. An additional ICU consultant was rostered over the following 48 hours. Similar extra staffing was required in the operating theatre suite over the ensuing 14 days.

A multi-disciplinary hospital audit was convened four months after the events of July 7th and many organisational issues were reviewed. These are listed below.

1. Major Incident Plan
- Communication problems. Mobile networks and switchboards may cease to function.
- Use of landlines and runners if necessary.
- Chemical contamination should be considered even if ruled out at scene.
- Use of toxicology bedside testing still not resolved in ICU.

2. Casualties
- The priority remains the transmission of medically related information and identification.
- Police and forensic issues should not interfere with the treatment of patients of their relatives in the initial stages.

3. Staff
- Staff welfare is the number one priority.
- Security in these circumstances cannot be over-emphasised: secondary devices are likely; hospitals are soft targets.
- All staff need rest. After initial response serious consideration must be given to standing staff down and keeping others in reserve. Another unrelated incident can occur at any time.
- Staff may need on-going support. This is normally dealt with by talking the issues through and does not necessarily require outside agencies to be involved.

4. Media
- The media can be useful in disseminating information however they do not have automatic rights and their actions are governed by codes of conduct.
- Early contact with the media, giving specific details of the hospitals response would appear, on reflection unwise, given the nature of the threat faced and potentially pose future security problems.

Conclusions

This was a multiple-casualty incident with the critically-ill contained within the intensive care unit. The high survival rate of the ICU patients was probably due to a number of factors. The relatively low average age (41yrs) and general lack of co-morbidities combined with prompt surgical treatment on arrival to hospital undoubtedly contributed. Previous literature has suggested that blast injury often leads to multiple organ dysfunction and prolonged critical illness (8), but this did not seem to be a clinical feature from our patient population. It has been further intimated that traumatic amputation is a marker of severe injury (9) but in our patient group, despite amputation being a predominant feature, it did not necessarily correlate with severe multi-system injury or mortality. This seems surprising, as the detonations occurred in the relative confines of tube train carriages and tunnels and in a bus. The initial management focussed on the basics of intensive care; achieving optimal oxygenation and perfusion, with a shift in individual patient management dependent on the injury profile. This approach has been validated in pre-

vious literature from Israel (10). The ability to contain the casualties within the geographical location of the ICU probably also contributed the low mortality. Mass casualty incidents (MCIs) are defined by their ability to overwhelm the medical and public health services of a community (11). Although stretched on July 7th, the medical services were not overwhelmed and it is difficult therefore to know whether this was truly an MCI.

Each individual terrorist incident and the pattern of injury produced are unique in nature. Each major incident plan is only as good as the last time it was tested for real. Medical management in these situations can be replaced by panic, chaos and emotional trauma. These elements are best combated by prompt leadership and some form of pre-existing plan (12). The day-to day emergency workload of the RLH ICU combined with a reasonable major incident plan and the flexibility of the personnel meant that there was no sense of hopelessness. There has been much published subsequently about the psychological response to such events in groups and individuals (13).

Injuries to civilians from conventional weapons during peacetime and their threat are now realities in the UK. These are predominantly likely to be blast injuries. Military doctors are ideally placed to provide clinical expertise and guidance in this field.

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